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DUPLEX TELEGRAPHY.

By W. H. PREECE, Memb. Inst. C.E. and Soc. T.E.

(Continued from page 217).

BEFORE discussing the irregularities to which circuits are liable, when worked on the duplex principle, and the means adopted by the different plans to remove or lessen the defects caused by them, as well as the improvements that have been recently made, it will be better to explain the other methods of working alluded to.

(*b*). *The Wheatstone Bridge principle.*—The differential principle is dependent, as has been explained, upon producing an equality of *currents;* the Wheatstone Bridge principle is dependent upon producing an equality of *potentials*. Potential is that property of electricity which determines its motion. It is an analogous term to *pressure* as applied to fluids and gases, and to *temperature* as applied to heat. Since heat cannot be transferred from one point of a conducting mass to another unless these points are at a different temperature, water cannot be transferred from one point of a river to another unless these points are at a different level; gas cannot be transferred from one point of a pipe to another unless these points are at a different pressure, so electricity cannot be transferred from one point of a conductor to another unless these two points are at a different potential. This transference of electricity is the so-called *current*, and the rate at which this current flows, or its *strength*, between any two points connected together by a conductor varies with the difference of potential of the two points. The strength of a current, like the flow of water through a uniform pipe, is the same at all points of its path, but its potential necessarily varies at each point. If it did not vary, there would be no current. The transference is invariably from the higher to the lower potential, so that if we raise or lower the potential of a point of the conductor, we either determine the flow of a current, or we change the strength of an existing current. By knowing the fall of potential we know the direction of the current, and by knowing the rate of fall we know the strength of the current. If the resistance of the conductor remains constant, the rate of fall varies directly with the difference of potential; if the difference of potential remains constant, the rate of fall varies inversely with the resistance of the conductor. This is only another way of expressing Ohm's celebrated law, viz., that the strength of a current varies directly as the electromotive force or difference of potential producing that current and inversely as the resistance obstructing that current. It is a very convenient method to represent the potential of a current at any point of its circuit by an ordinate or vertical line at that point whose height is proportional to the magnitude of the potential at that point. The potential of the earth being always regarded as O, it cannot be represented by any ordinate, and therefore it is taken as the zero line. If ordinates be raised at every point of a conductor, it is readily seen that the potential of the current falls uniformly from the source of the current where it is a maximum to the point where it is in connection with the earth, and where, consequently, it is nothing. If the magnitude of the potential at any point, A, (Fig. 10) of a conductor or circuit, A B, be represented by A *a*, and *a* B be drawn, then, if we take any point, *x*, *x y* will represent the potential at that point, and the figure, A *a* B, will represent the distribution or fall of potential along the circuit, A B. The figure shows that the current flows from A to B, and that its strength is proportional to its rate of fall, or to the angle, *a* B A. If, now, from A (Fig. 11),* two circuits start, A B and A B′, and A *a* be the potential at their point of divergence, the fall of potential in each will be that shown in the figures, A *a* B and A *a* B′, the direction of the currents will be respectively from A to B and from A to B′, and there must be two points, C and C′, whose ordinates, C *c* and C′ *c*′, are equal, and whose potentials must, therefore, be the same. Now, since the simple conditions of a current are these—that there shall be two points at *different* potentials connected together by a conductor—it follows that when two points at the *same* potential are connected together, there can be no current between them. Hence, when C and C′ are connected together by a conductor, no current will flow between them. These points are not arbitrarily taken, for if we take any point in the triangle, A *a* B, there must be a corresponding point in the triangle, A *a* B′, which has a similar and equal ordinate. Geometry tells us that these points are such that

$$AC : CB :: AC' :: C'B'$$

Hence, when A C is equal to A C′, C B is equal to C B′. This is, as is well known, the principle of the Wheatstone Bridge, the most valuable and useful apparatus in the laboratory of the electrician.

FIG. 10.

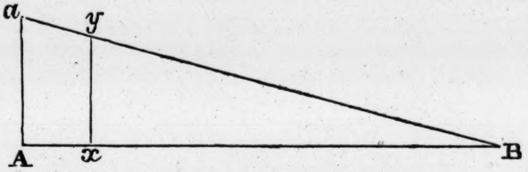
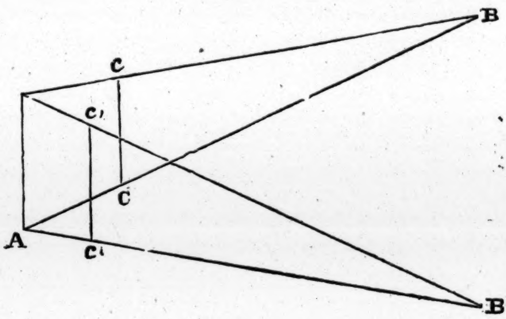


FIG. 11.



Now let us connect up the instruments required to communicate between the two stations, A and B, in the manner shown in Fig. 12. C C′ is the line wire, R is an artificial resistance equal in value to the whole circuit between C and the earth, consisting of the line and the combined apparatus at B. A C and A *c* are two artificial resistances which, for the present, we will take as equal to each other, and to some large fractional part of the line circuit. The key (K) is connected up with the battery in the ordinary way, as shown in the figure. The relay (P) is fixed between C and *c*. The recorder, which is worked in the ordinary way by the relay, P, is not shown in the diagram for the sake of simplicity. The apparatus at B is precisely the same in every respect. Now, when A depresses this key (K), a current is sent, and this current splits at *a*, one portion passes through the line wire to B, making earth through the apparatus at that station, and the other passes through the artificial coil, R, to earth at A. These two currents are equal, since their resistances are equal, and their rate of fall of potential is the same. Again, since the points C and *c* are equidistant from *a*, their potentials are the same, and therefore no current passes between them. Hence, the relay is not affected, consequently while A alone is sending to B, its own apparatus is not disturbed. The same exactly occurs when B alone is working to A. Thus we have the first condition of duplex working:—we are able to send currents to a distant station without affecting our own apparatus.

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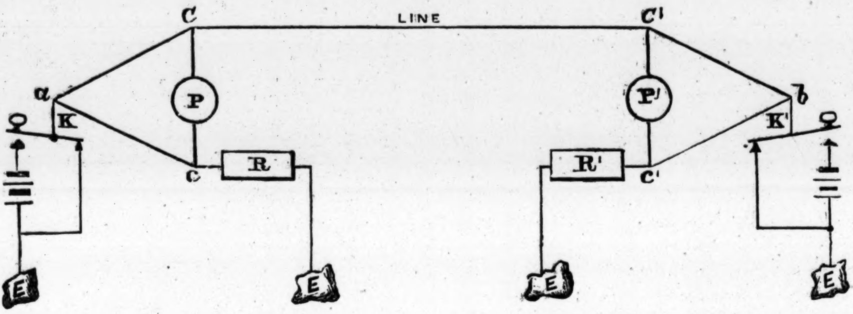
* These diagrams are drawn according to the rules of solid geometry. The triangles are supposed to be in different planes.

FIG. 12.



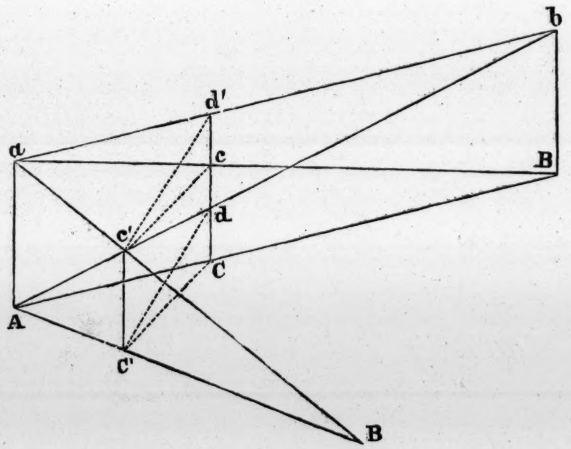
The apparatus at B duly registers its marks when A is sending, for the line current at C' has two paths open to it,—the one through C' *c'*, the other through C' *b*. That through C' *c'* works the relay, and causes marks to be recorded. The relative strengths of these two currents depend upon the relative resistances of all the parts, C' *c'*, C' *b*, *c'* E, *c' b*, and *b* E. For since the strengths of the currents depend upon the rate of fall of potential in the branch C' *b*, and through the relay in C' *c'*, and this rate of fall depends upon the resistances in them and in *c'* E and *c' b*, it follows that as we vary the resistance of these branches we vary the potentials of the points C', *c'*, and *b*, and therefore the rate of fall, and consequently the strength of the current, through C' *c'*.

If the resistances of the branches be equal to each other and to *c'* E, then the current passing through C' *c'* is very nearly equal to that passing through C' *b*. It would be exactly equal if the resistance of the relay were equal to half either branch. But there is no necessity for the resistances of the branches C' *b*, *c' b* being equal, as I have assumed. They may bear any ratio to each other in accordance with the bridge principle, and by making the resistance of *c' b* small compared to C *b* we obviously increase the strength of the current passing through C *c*, for we lower the potential of the point *c'*. If we made the resistance of *c' b* *nil* nearly the whole of the current would pass through C' *c'*, if the resistance of C' *c'* be small compared to C' *b*, but we could not establish a balance, and duplex working would be impossible. Similarly, and under similar circumstances, if we made the resistance of the branch *c'* E *nil*, nearly the whole of the current would pass through C' *c'*; but again duplex working would be impossible, for the balance or equality of potentials depends upon the ratio of the resistance of *c' b* to *c'* E being the same as that of C' *b* to the line.

To maintain duplex working we must establish a balance,—that is, we must maintain the potentials of the points C' and *c'* equal when B is working to A. Hence, as we vary the resistance of *c' b*, we must vary that of *c'* E in the same proportion.

But the reduction of the combined resistance of the branches *c' b* and *c'* E has an effect upon the outgoing currents which must not be lost sight of,—that is, upon the currents that B sends to A, or *vice versâ*. The smaller this resistance is made the lower it reduces the potential of the point *b*, and the smaller it makes the strength of the outgoing line currents. Hence it is very evident that the resistances of all the branches must bear a given ratio to each other, to produce the maximum effect upon the relay, P, at both stations, and that this will vary with every circuit. Generally, it may be said that the smaller we make the resistance of the battery the more we can afford to reduce the resistance of the branches *b*, *c'*, E, and therefore the greater will be the proportion of the received current passing through the relay in C' *c'*, and the larger we make the resistance of C' *b* compared to C' *c'* the greater will be the difference of potential between C' and *c'*, and consequently the stronger the current passing through it.

FIG. 13.



Thus it will be seen that when A is working to B alone, or B working to A alone, its own apparatus is not affected, and marks are duly recorded at B or A, as the case may be. When A is sending to B at the same time that B is sending to A the equality of the potentials at the points C *c* and C′ *c′* is disturbed; they vary, currents pass, and these currents are in the same direction and of the same strength as the ordinary currents when one station alone is working. For supposing, as in Figs. 11 and 13, that A *a* B and A *a* B′ represent the distribution of potential when A alone is sending to B, and that when B alone is sending to A the potential at B is raised to B *b′*, as shown in Fig. 13; then the triangle B *b′* A represents the fall of potential along the line circuit, and the little triangle C *d* C′ represents the fall of potential through the relay. I have assumed, for the sake of simplicity, that when B is sending to A the points A and C′ are at the same potential, viz., that of the earth. This is not strictly correct. They are or should be practically at the same potential, but it is above that of the earth, for there is resistance between them and the earth. If the sum of the resistances between them and the earth in each case be equal, then they will be exactly at the same potential, and the reasoning holds good. To show the exact distribution would complicate an already complicated figure. Now let B work to A at the same time that A works to B; then the potentials of A and B become the same, that at C becomes C *d′*, and the fall of potential through C C′ is represented by the triangle *c d c*. It is very evident that the triangles C *d* C′ and *c d′ c′* are equal and similar, and consequently that the currents which pass through C C′ are equal when one or both stations are working.

I have also assumed the potential at B to be equal to that at A, and uniform throughout the line, neglecting the effects of imperfect insulation; but it is very evident, from an inspection of the figure, that whatever be the potential at B, and however it be distributed along the circuit, the potential produced by B at C—when B alone is working—will be added to or subtracted from that produced by A when working alone, and therefore the difference of potential between C and C′ will be the same whether B be working separately or simultaneously with A. Hence the currents through C C′ are not disturbed by duplex working. Hence while A is sending messages to B, B can also send messages to A upon the same wire and at the same time.

The chief point of this method, which characterises it from the previous methods described, is that it is independent of the character of the apparatus used for receiving messages. It will work as well with the most delicate mirror apparatus as with the roughest Morse recorder; the elegant and simple sounder can be manipulated as well as the rapid Wheatstone automatic instrument. Thus no special form of apparatus is needed for its use excepting the supply of resistance coils.

[Note.—In Fig. 4, p. 215, the line connecting *a* and 2 of the left hand relay from the point where it crosses the dotted line has, unfortunately, been omitted in the woodcut. The figures, also, should have been numbered consecutively from 6 to 9.]

The India-Rubber, Gutta-Percha, and Telegraph Works Company have received a telegram from Captain Hunter, R.N., announcing that he had picked up the cable between Jamaica and Colon, in 1700 fathoms.

MATHEMATICS
FOR
NON-MATHEMATICIANS.

By WILLIAM PAGET HIGGS, LL.D., D.Sc.

Division I.—The Algebra of Constant Quantities.

(Continued from p. 233.)

Tables of Logarithms.

Tables of logarithms are usually arranged to give the mantissæ of the natural numbers consisting of one to five digits,—that is, from 1 to 10,000; and when the given number, or *argument* as it is termed, has no more than five digits, its logarithm is found in the tables on inspection. But it will often occur that the argument has more than five digits, and the logarithm is found by following this reasoning:—Let us take* the log. of 6276153. Now it can be shown that when any two large numbers differ by unity the increase of the logarithm is sufficiently nearly proportional for all practical purposes to the increase of the number. We look then in the table for the logarithm of 62761 and for that of 62762, and find the mantissæ 0·7976899 and 0·7976988 respectively. The logarithm of 6276200 is then = 6·7976988, and that of 6276100 = 6·7976899. Their difference is 0·0000089. Thus for a difference of 100 in the numbers the difference of the logarithms is 0·0000089. We have then the common rule-of-three sum:—If 0·0000089 added to the logarithm of 6276100 gives the logarithm of 6276200, what must be added to the log. of 6276100 to give the log. of 6276153?

100 : 53 :: 0·0000089 : the number to be added;

or—

$$\frac{53\times 0{\cdot}0000089}{100}=0{\cdot}000004717.$$

Disregarding the last two figures, we have—

$$\log.\ 6276153=6{\cdot}7976899+0{\cdot}0000047=6{\cdot}7976946.$$

Should the first of the figures omitted, however, be higher than 5, or 5 itself, 1 should be added to the number preceding it.

Had the log. of 627·6153 been required, or that of 0·0006276153, we have seen in the foregoing that they would be respectively 2·7976946 and $\bar{4}{\cdot}7976946$.

Now that we have seen the reason, the rule to find the log. of a given number whose digits are in excess of those given in the table may be stated thus:—Find and write down from the table the mantissa for as many digits as are given. Take the difference between that mantissa and the next greater. Consider the remaining figures of the given number as a decimal fraction, and multiply the difference by this fraction, rejecting as many figures from the right of the product as the multiplier contains. The result added to the lesser mantissa is the mantissa of the logarithm of the given number. Study of the example given above will explain this apparently difficult rule.

The number to be added to a lesser log. to give the log. required is termed the *proportional part*, and is given in the best tables. But as these are variously arranged, we leave the student to consult the instructions accompanying the tables he may select, content ourselves with imparting to him the *reason* for what he there will be directed to do.

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* This and the next example are from p. 125 of Prof J. H. Smith's "Treatise on Elementary Trigonometry," a work we advise the student to procure.

How to find the number to which a log. corresponds we have next to consider. The number may be found exactly in the table, but it may also occur that the exact number is not given exactly. We then state proportionally the difference between the log. next less and that next greater, and the difference between their corresponding numbers :—Thus, suppose we wish to find the number corresponding to the logarithm 3·9212074, the tables give—

$$\text{log. } 8340{\cdot}8 = 3{\cdot}9212077$$
$$\text{log. } 8340{\cdot}7 = 3{\cdot}9212025.$$

That is,—if a difference of 0·1 in the numbers gives a difference of 0·0000052 in the logarithms, what difference in the numbers will a difference of—

$$(3{\cdot}9212074 - 3{\cdot}9212025) \text{ or } 0{\cdot}0000049$$

in the logarithms give?

$$0{\cdot}0000052 : 0{\cdot}0000049 :: 0{\cdot}1 : 0{\cdot}094,$$

which added to 8340·7 gives 8340·794.

Rule.—Subtract from the given log. the next less tabular log., and this tabular log. from the next greater tabular log. Divide the first difference by the second or tabular difference, and the first two or three figures of the quotient annexed to the figures of the lesser tabular number will be the number required.

Example—

$$\begin{array}{r} 3{\cdot}9212074 \\ 3{\cdot}9212025 \\ \hline 0{\cdot}0000049 \end{array} \qquad \begin{array}{r} 3{\cdot}9212077 \\ 3{\cdot}9212025 \\ \hline 0{\cdot}0000052 \\ 52\underline{)49} \\ {\cdot}94 \end{array}$$

and this annexed to 8340·7 gives 8340·749, as before.

The Arithmetical Complement.—This device, discovered by Gunter about 1614, although of very constant use with logarithms, is not by any means an invariable accompaniment of logarithmic tables. Indeed, the addition of the arithmetical complement to every logarithm would render the tables exceedingly unwieldy, and is the more unnecessary since the complement may be very easily calculated. The rule is—*begin at the left hand, and subtract every figure from* 9 *until the last ; subtract that from* 10. The reason for the rule is too obvious to need explanation, but an example may aid the student. Thus to find the arithmetical complement to the log. 2=0·30103.

$$\begin{array}{ccccc} 9 & 9 & 9 & 9 & 10 \\ 3 & 0 & 1 & 0 & 3 \\ \hline 6 & 9 & 8 & 9 & 7 \end{array}$$

and to log. 7=0·84510,

$$\begin{array}{ccccc} 9 & 9 & 9 & 10 & \\ 8 & 4 & 5 & 1 & 0 \\ \hline 1 & 5 & 4 & 9 & 0 \end{array}$$

Results which the student can verify by reference to the table on p. 232.

Transformation of Systems of Logarithms.

Hitherto we have considered only the common system of logarithms, or those calculated to the base 10. It is, however, evident that there may be other bases, and consequently other systems of logarithms. The celebrated Baron Napier, the discoverer of logarithms, employed as a base the sum of the following series,* denoting the sum by ε.

$$2 + \frac{1}{2} + \frac{1}{2.3} + \frac{1}{2.3.4} + \text{to infinity.}$$

The first eight digits of this sum are 2·7182818, and this is the base of what is known as the Napierian or hyperbolic system of logarithms. This system is used in present scientific investigation, and the general principles of the conversion of this system into the common, or of the common into this, will be of service to the student.

Suppose there are any two systems of logarithms whose bases are b and B, and that there is a number n which has x for its log. in the first system and y for its log. in the other system. Then n will be equal to either b^x or B^y, and as we have the first of mathematical authorities—old Euclid—for the assertion that "things equal to the same thing are equal to one another," we may say that b^x is equal to B^y. And if we refer to the principle of the equation given in an earlier page we shall see that (which is or should be self-evident) if we divide the x on one side by the y on the other we still maintain an equation, and that $B = b^{\frac{x}{y}}$ (or dividing by y on both sides we have $B^{\frac{x}{y}} = b^{\frac{x}{y}}$, the same thing). Therefore (see p. 222) $\frac{x}{y}$ is the log. of B to the base b; and writing this—

$$\frac{x}{y} = \text{log.}_{\,b}\, B,$$

we shall at once see the inverse or reciprocal to be—

$$\frac{y}{x} = \frac{1}{\text{log.}_{\,b}\, B}.$$

The reciprocal is taken to allow of readily multiplying both sides of the equation by x, whence we obtain the value of y, which is—

$$y = \frac{1}{\text{log.}_{\,b} B}.$$

And this teaches us that if the log. of any number in the system of which the base is b be multiplied by—

$$\frac{1}{\text{log.}_{\,b}\, B},$$

we shall arrive at the log. of that number to the base B. The multiplier or constant—

$$\frac{1}{\text{log.}_{\,b}\, B}$$

is termed the *modulus* of the base B with regard to the base b.

The modulus of the common system of logarithms with relation to the Napierian system is, it follows,

$$\frac{1}{\text{log.}_{\,\varepsilon} 10},$$

and as the numerical value of log. $_\varepsilon$10 is by calculation 2·30258509, this number divided into unity gives 0·43429448, the modulus of the common system, or the number by which the Napierian logarithm must be multiplied to give the corresponding logarithm of the common system. Similarly 2·3, &c., is the modulus by which a common logarithm is to be multiplied to obtain the corresponding Napierian logarithm.

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* For an explanation of this term the student is referred to subsequent pages.

In practice the reduction of common to hyperbolic logarithms may be effected, but only approximately, by multiplying the common logarithm by 2·3.

When presently more advanced, the student may with advantage return to this chapter, and trace the reasoning embodied in the following formulæ:—

It may be shown that—

$$\log._b B \times \log._B b = 1.$$

For if $b^x = B^y$, then $b = B^{\frac{y}{x}}$

$$B = b^{\frac{x}{y}}; \text{ and}$$

$$\frac{y}{x} = \log._B b,$$

$$\frac{x}{y} = \log._b B. \quad \text{Therefore}$$

$$\log._b B \times \log._B b = \frac{y}{x} \times \frac{x}{y} = 1.$$

Another exercise, and one by which speed and accuracy in calculation may be gained, is the finding of certain logarithms from other given logarithms.

Given the log. of 2=0·3010300 to find the logs. of 64 and 128.

Now 64 is the sixth power of 2; hence by Rule III. the log. of 64 will be six times the log. of 2. The log. of 64 is 1·8061800.

The log. of 128 will be the log. of 64 plus the log. of 2, or seven times the log. of 2.

The following example, adapted from one given by Prof. Smith, affords very useful illustration:—

Given log. 5=0·6989700, find the log. of $\sqrt[7]{(6{\cdot}25)}$.

By Rule IV. the log. of the seventh root of 6·25 is equal to the seventh part of the log. of 6·25. Now we may write 6·25 in the form of a mixed vulgar fraction, as $\frac{625}{100}$, and the resolution of this fraction by logs., according to Rule II., is log. 625 − log. 100, because the form of the fraction indicates that 625 is to be divided by 100; 625, again, is the fourth power of 5, and 2 is the log. of 100. Then—

$$(\log. 625 - \log. 100) = \log. 5^4 - 2).$$

And as the log. of the fourth power of 5 is equal to four times the log. of 5, the expression—

$$\frac{(4 \log. 5 - 2)}{7},$$

which may be read four times the log. of 5 less 2 divided by 7, will give the answer.

$$\begin{array}{rr}
\text{Log. } 5 = & 0{\cdot}6989700 \\
\text{multiplied by } 4 & 4 \\
\hline
 & 2{\cdot}7958800 \\
\text{less } 2 & 2{\cdot}0000000 \\
\hline
\text{divided by } 7) & 0{\cdot}7958800 \\
\hline
 & 0{\cdot}1136114
\end{array}$$

And by similar applications of the four primary rules many examples may be put and solved by the student himself.

ON SOME RESULTS OF WEATHER TELEGRAPHY.*

By ROBERT H. SCOTT, F.R.S.

THE popular idea of weather telegraphy appears to be that reports from a number of outposts are received at a central station, and that the person charged with the duty of discussing the information is able to deal with the collection of observations so received with the same confidence as if he had taken the readings himself, and had a perfect knowledge of the entire character of the weather at each locality. It is hardly requisite to remark that the above is very far from being the real state of the case. The reports are necessarily sent in a condensed form in order to save expense, and the choice of situation of the several stations has been, perforce, ruled by many considerations besides mere suitability for affording unexceptionable information.

Even though the information were sufficient, both in quantity and quality, to give us a good idea of the instrumental readings over the country, it is quite impossible to get a complete account of the general conditions of the weather at each place in a telegram short enough to be transmitted at a fair cost.

In the United States the system of weather telegraphy is conducted on a far more extensive scale than in these islands; while we, for our part, are far in advance of all other European states. The signal office at Washington receives 3 reports a day at equidistant hours from about 80 stations; while we have, or should have, did the reports arrive punctually, 46 reports in the morning and 9 at 2 p.m. It is a fair question whether or not the cost of the American system as compared with our own is not excessive. The grant from Congress to their service is 250,000 dols. for last year; while we spent hardly one-fourteenth of that sum, viz. £4000.

I have not yet alluded to one of the most serious obstacles to the development of a perfect system of weather telegraphy. This is the frequency of telegraphic errors. In this connexion I do not merely speak of the foreign reports; for the Society can easily understand that a report from Corunna, passing through French and English offices, where the clerks are innocent of Spanish, is often all but unintelligible. It is the errors in our own reports which are the great trouble to us. Of these errors, great and small, there were, during the year 1872, about 300 which were traced, though we did not formally report more than one-fifth of this number, to the Post-office by letter. Many of these errors arise from the fact that our code consists mainly of figures, in the transmission of which mistakes are especially likely to arise. These mistakes in telegraphy, as well as the delays in transmission, are, unfortunately, more frequent at a period when the weather is disturbed than in time of calm; so that at the very moment that we are most in want of full information it is all but impossible to obtain it.

Admitting, however, that we possess a reasonable number of well-equipped stations, a good staff of observers, and that we enjoy a moderate freedom from telegraphic errors, the fact still remains that we have in these islands the most exposed district in Europe, except, perhaps, the north-west coast of Norway, and that we must do the best we can.

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* Abstracted from the "Quarterly Journal of the Meteorological Society," for July, 1873. Communicated by the Author.

The idea of mooring ships or large buoys off our western coasts to form advanced posts of observation may be given up as sufficiently chimerical, at least until it has been proved to be practicable. It is an acknowledged principle with the Trinity House and the other two Lighthouse Boards, that no lightship or lighthouse can, with safety to life, be placed in any situation where it cannot be visited once a week at the least. It may safely be said that a vessel moored 100 or even 50 miles west of the Fastnet could not have been visited more than once or twice during the two months succeeding the middle of November last.

The idea of obtaining information from the United States is nearly equally visionary; for the whole phenomena of the storms change their character entirely in travelling over any considerable portion of the earth's surface.

Recently, the Portuguese meteorologists, at the suggestion of Professor Buys-Ballot, have proposed to furnish observations from the Azores as soon as a cable shall have been laid from that group of islands to the mainland; but there is no reason for expecting that reports from the Azores would be of any service to us as giving direct intelligence of storms which are advancing on our coasts.

As regards our system of reports and warnings it is undeniable that our telegraphic code is more complete and satisfactory than any other in Europe, inasmuch as, besides giving the rainfall and hygrometric information, it enables us to make a barometrical chart for 6 p.m. with nearly the same accuracy as that for 8 a.m.

As to the warning messages to the coast stations they are necessarily very concise. Any idea of telegraphing gradients, or even barometrical readings, to uneducated fishermen at the present day, bears on the face of it unsuitability to the requirements which the warnings are mainly intended to meet, whatever hopes we may cherish of the future enlightenment of our sailors. It is true that at some stations, such as Whitby, the telegrams received are regularly discussed by the fishermen with the view of eliciting from them the extent of danger to that part of the coast; but it is very seldom that such trouble as the above is taken.

Two plans have been proposed for conveying the intelligence to ships passing or at anchor, as at the Downs or in Yarmouth Roads. In the plan employed in Holland for several years, there is used an instrument called the Aëroklinscope, which consists of a bar slung by the centre like a ship's yard, but capable of being turned in any azimuth, and of being peaked to any angle. The practical difficulty in the use of this plan is that it is very hard to read it if you do not face it exactly, for you cannot be quite certain which end of the arm is the nearer to you.

My own impression as to the form of signal is, that we shall probably either abide by the drum, or revert to the use of the drum and cones in a signification somewhat similar to that which they had in Admiral FitzRoy's time.

In each year there are about 20 per cent of warnings which were justified by the occurrence of strong winds, though not by gales: these we count as successes, and thus the total percentage of success in the three years respectively is 68, 63, and 80. This last figure is slightly higher than that which was obtained in the office for Admiral FitzRoy's warnings, and, of course, far higher than that given in the Report of the Committee appointed to consider the condition of the office on Admiral FitzRoy's death.

The Signal Office of the United States claims 76 per cent of success for its warnings; and I think that we may say that our result for last year of 80 per cent of storms and strong winds occurring after the hoisting of the drum is a fact on which we have just reason to congratulate ourselves.

THE
ARGENTINE NATIONAL TELEGRAPHS.

We have been favoured with the Official Report (for the year 1872, ending June 6, 1873) presented to His Excellency the Minister of the Interior of the Argentine Republic, Dr. Don Uladislao Frias, by the energetic Director-General of Telegraphs, Mr. Charles Burton.

The figures show well the facility with which the Argentine public has become accustomed to the use of the national telegraphs, and place in relief the immense increase which has taken place in each four months since the inauguration on the 10th September, 1870, commencing with a charge per telegram of from 1s. to 4s., according to the distance. On the 1st of January, 1873, was put in force the uniform tariff of 25 cents (¼ dollar, or 1s.) per telegram, irrespective of distance.

During 1872 the number of telegrams forwarded amounted to—

In 1st four months	48,558
„ 2nd „ „	58,184
„ 3rd „ „	75,033

The work done in six of the principal offices only—Buenos Ayres, Rosario, Cordova, Santiago, Tucuman, and Parana—during the year 1872 has amounted to the enormous number of 414,172 transmissions and receptions, Rosario having the highest number—160,795—through being the centre of several sections.

In the year 1872 sections amounting to 890 miles were opened; and in the year 1873, from January to May, 176 miles have been opened.

Of the total extension of national telegraphs, continues the Director-General, we have 1319 miles of line upon iron posts, comprised in the river-side lines in the provinces of Buenos Ayres, Santa Fé, Entre-Rios, and Corrientes, and from Rosario to Cordova. On the rest of the lines through the provinces of the interior beyond Cordova wooden poles have been used. The wire placed upon the river-side lines is No. 7 B.W.G., and upon the others it is No. 8.

Obviously the want of wires is very prejudicial to the public, when replies cannot be obtained with the requisite promptness.

To remove the present difficulty two wires more have been ordered to be put up from Buenos Ayres to Cordova. One of these wires will be devoted to the transmission of despatches for the Western Provinces and Chile, by way of the Transandine Telegraph, which terminates in Villa Maria. The other wire will place Cordova in direct communication with Buenos Ayres, to avoid delay in transmission to the Northern Provinces.

Another wire is also ordered to be added to the line from Rosario to Santa Fé. This wire will serve the towns of the Province of Santa Fé, leaving the two existing wires free for the communications from Rosario to Parana for the Provinces of Entre-Rios and Corrientes.

Those liberal-minded Governments who have not made a speculation of the telegraphs, and who have desired only to facilitate equal privileges to all towns, great or small, have not been able generally to reimburse the money expended until several years have elapsed after the construction has been concluded; but everyone has become convinced, sooner or later, that true economy and utility result only from the institution of low tariffs.

My assertions are corroborated by the following data:—

In France, from 1855 to 1867, the only profitable years were 1856, '64, '65, '66, and '67. The tariff commenced at 2 dols. 66 cents, but in the last year it remained at 20 cents.

In Belgium, from 1851 to 1868, the profitable years were 1852, '53, '54, '55, '56, '57, '58, '59, '60, '61, '62, and '64. Commenced with a tariff of 1 dollar, but now remains at 10 cents.

In Switzerland, from 1852 to 1868, the profitable years were 1854 and after 1856. Commenced with a tariff of 20 cents, reduced in 1868 to 10 cents.

In Prussia from 1852 to 1867, the profitable years have been all, after 1855 inclusive, with a tariff of 1 dollar 60 cents.

In Sweden, from 1853 to 1868, always profitable, with a tariff of 30 cents.

In Norway, from 1854 to 1867, there has been no profitable year; there exists a tariff of 28 cents.

In Italy, from 1861 to 1868, the profitable years were 1866, '67, and '68.

In Greece, from 1861 to 1868, there has been no profit.

Several serious stoppages have occurred on the lines, and interruptions, which served to expose any slight defects which might have been caused during construction, but which have been remedied immediately, the communication being re-established without the service suffering materially. The first section of the national telegraphs from Rosario to Parana was opened in 1870, when the latter city was in a state of siege. The revolutionists cut the wires simultaneously in different places, and being unable to obtain persons to keep them in working order I was under the obligation of supplying the want personally. This work occupied me for two months incessantly, having to make repairs every day, but, notwithstanding the turbulent times which existed, I succeeded in providing a fairly regular communication between Rosario and Parana. The most serious damage was caused by the rebels cutting the submarine cable in front of the Brete, about 2 leagues from Parana. I repaired this when the enemy's camp was under a mile distant, with reconnoitring parties coming to the beach.

At that time this cable was 1200 metres long, but in 1871 a large piece of the island on which it was landed was carried away by one of the strong floods of the River Parana. To repair it this time I had to grapple for the end of the cable, which was in 9 yards of water. The force of fourteen men was insufficient to raise the cable, it being fastened to a terminal iron pole, and the whole entangled in and underneath two trees. Ultimately it was recovered by the aid of machinery, when I found it necessary to join 100 metres of new cable to re-establish the communication with the aërial line.

From this point the line passes towards Santa Fé over islands where interruptions have taken place several times. The swampy nature of the ground renders the repairs laborious, but they have always been completed in the course of a few hours.

In the River Mini there is another cable of 126 metres; the aërial line continues to the River Colastiné, where there is another cable of 600 metres, before arriving at the office of Rincon. Between this office and that of Santa Fé the Laguna of Guadaloupe is passed by another cable, which, when it was laid, was only 240 metres long; but in the past year of 1872 it was necessary to join 90 metres more, as during a great flood a ship had carried away a terminal pole which was on the inundated ground, leaving even the aërial line under water.

Difficulties of other nature have also presented themselves, but, depending on the action of Congress or of the Government, have partly disappeared, and it will be easy to remove them altogether.

From the 1st of January, 1872, according to the Budget sanctioned by Congress, the wages of the linemen were reduced to 30 hard dollars per month. These men have to go over their districts generally in stormy weather, as the rainy season is the most unpropitious for the telegraph. They must have sufficient experience to be enabled to repair the line in such a workmanlike manner that the conductive power of the wire be not diminished through their incapacity or neglect. They must also buy and maintain at their own cost the horses, which are indispensable for the long journeys which they must at all times undertake, carrying with them the necessary tools, following closely the telegraph, over rivers, swamps, and, in fact, all kinds of country, as, if they were to leave the direct route of the telegraph to find a good road, an interruption in the wires might be passed unobserved. With the reduced salary of 30 hard dollars none of the experienced men wished to stay. In consequence of this inconvenience I communicated to the Government that it was necessary to authorise me to pay an additional salary. Being convinced of the urgency of the case, and with the requisite authority, I defrayed from my personal resources these additional expenses for half a year; but in the month of July I discontinued further payment, finding the expense too onerous. His Excellency the Minister of the Interior then presented to Congress a project of law, asking funds for this object, which I communicated to the *employés*, being enabled by this assurance to keep the majority of them until the end of the year. Only recently, in 1873, these additional salaries have been liquidated, the delay causing the retirement of more *employés*. At present the salary paid the linemen is 40 hard dollars monthly, and yet insufficient, and more of them will leave the service if an increase be not accorded for the coming year of 1874. The want of money to pay their expenses makes it impossible for them to fulfil their duties promptly, the delay which results being very prejudicial to the receipts and to the public.

Attached to the Direction in the year 1872, I arranged a workshop, which, from its inauguration to the present, has been attended by the Sub-Inspector, who has repaired our disabled instruments without receiving any remuneration. Although the staff of the Direction is so small, the building occupied is so incommodious that the clerks are huddled together in the midst of materials, anxiously waiting the construction of the proposed new offices, which, according to the plans, will be able to contain, though without any superfluous space, all the staff, including that of the office of transmission also. During the past year of 1872 the *employés* in general have been much overburdened with work, frequently having to remain at their posts until midnight, without receiving any extra pay whatever. I consider that they merit any recommendation which I can afford them for the good will with which they have performed their duties. The total number of *employés* in the service is 235.

We are glad to see that the Argentine public press support the energetic endeavours of Mr. Burton in the establishment of efficient State telegraphs.

Students' Column.

Electrical Length.

THE term "electrical length" has been employed in contradistinction to the ordinary or physical term by which the idea of length is conveyed. Electrical length is of course synonymous with electrical resistance. In the laboratory, and even in our handbooks, the expression "a wire of so-many ohms" is common, and it is necessary that the student should dissociate the idea of physical length from such an expression. To the electrician the expression "a wire of 10 ohms," or "10 ohms of wire," conveys as distinct meaning as "10 yards" or "10 miles" laid out by ordinary physical measurement. Given a definite electrical unit of resistance, it is always as easy to measure by electrical appliances the value of that resistance as it is to put a rule or tape by the side of a wire, and to say how long is the wire. A circuit, then, of ten ohms, electrical length does not necessarily include that it should be greater in physical length than one of five ohms, or just half the amount, because if the ten ohms' wire be a very thin wire only a short piece will interpose twice as much resistance as a mile of the five ohms' wire if the latter be very thick or coarse.

But in telegraphic or other work where one gauge of wire is principally employed, it is not unusual to speak of the actual length of the wire in terms of the resistance-coils. Thus, instead of saying that the line from London to Birmingham is so many miles in length, we may say it is so many ohms or units long, meaning that the line-wire between London and Birmingham has so many ohms or units of resistance, and our meaning is as clear and as true as if it had been expressly stated.

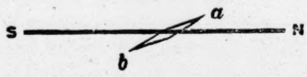
This idea of electrical length will bear great extension, and will be so extended during the discussion of electrical principles with our students. It is better, therefore, now to lay down clearly the difference between electrical and physical length.

PAPERS FOR JUNIOR STUDENTS.

Principles of Telegraphic and Testing Instruments.

OERSTED, in 1819, laid the foundation of telegraphic science, and of nearly all electrical measurements, when he described his celebrated experiment by which he showed the effect produced upon a magnetic needle by a galvanic current passing along a wire parallel to that needle. A copper wire is suspended horizontally in the direction of the magnetic meridian, over a movable magnetic needle, as shown in Fig. 1.

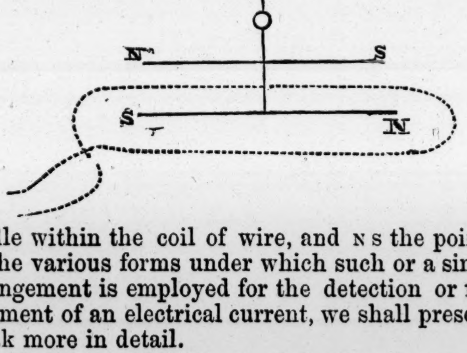
FIG. 1.



When a current does not exist in the wire, the needle remains parallel to it, but immediately the ends are connected to the poles of a battery the needle is deflected, the position of the needle approximating a right angle to the wire in the proportion as the current is more intense.

The experiment was thus described at p. 128 of this Journal, and it was remarked that "if we turn the wire back upon itself below the needle, so as to inclose the latter in a square or oblong frame, we increase the magnetic intensity developed by the current, and this increase will be proportional to the number of turns we make. We will now consider the applications of this principle of multiplying the effect of the current upon a magnetic needle. The first application we may consider is that of the ordinary galvanoscope. This instrument consists of a coil of wire wound in one direction upon a brass or wooden frame, inside the frame being suspended the magnetic needle. Sometimes the magnet is the pointer or index to the figures marked around the dial; more generally a separate index is attached to the axis of the needle, either parallel or at right angles to the needle. The needle may work upon a pivot as in a mariner's compass, or it may be suspended by a thread, as in Fig. 2, where S N is the magnetised needle within the coil of wire, and N S the pointer. Of the various forms under which such or a similar arrangement is employed for the detection or measurement of an electrical current, we shall presently speak more in detail.

FIG. 2.

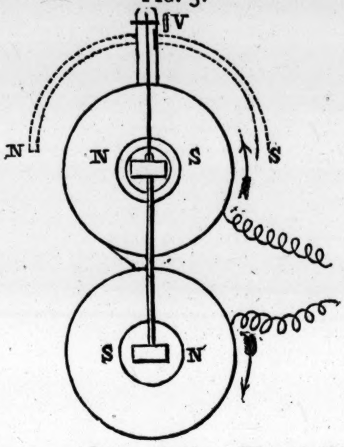


Delicacy, or liability to deflection by a weak current, may be secured to a needle (with a given coil) in two ways—by rendering the means of suspension such as to afford only the slightest possible friction, or by reducing the directive effect of the magnetism of the earth upon the needle,—or by a combination of these two systems. Evidently suspension by a thread, free from twist or torsion, is a means better adapted to reduce friction than the pivot method employed in the mariner's compass. And in order to secure freedom from torsion it is usual to employ a filament from the cocoon of the silkworm,—not a ravelling from a silk thread as is too often done by careless operators. The silk filament may be obtained direct from the cocoon itself, or may be taken from the article supplied by the silk manufacturer under the name of "tram," this being the unspun, or rather untwisted, fibre from the cocoon. When the fibre has been twisted it receives the technical name of "organzine."

The other method of rendering a magnetic system more delicate, by counteracting the directive effect of the earth's magnetism, is capable of and receives many important applications in electrical science. In Figs. 1 and 2 the earth exerts a certain directive force upon the magnetised needle, sufficient to cause the needle to resume its meridianal position when the disturbing agent is removed. Now were the pointer N S, in Fig. 2, another magnetic needle with opposite poles to the needle S N, and were these needles magnetised to exactly the same strength, the result would be that the earth's directive force upon S N would be counteracted by the earth's contrary directive force upon N S, and the needles would not have the least tendency to retain the meridianal position, but would assume a right angle to the meridian. Again, if N S possessed slightly less magnetic strength than S N, there would be a tendency to retain the meridianal line equal to the difference between the strengths of the two needles. So that it becomes possible to give to a magnetic system any degree of delicacy between the limits of no directive force and the full directive force possessed by one of the needles. A system of two or more needles (for sometimes four needles are thus arranged) uninfluenced by the earth's magnetism is said to be *astatic*. Upon this point M. Ganot says —"An *astatic needle* is one which is uninfluenced by the earth's magnetism. A needle movable about an axis in the plane of the magnetic meridian, and parallel to the inclination, would be one of this kind; for the terrestrial magnetic couple acting then in the direction of the axis cannot impart to the needle any determinate direction. An *astatic system* is a combination of two needles of the same force joined parallel to each other with the poles in contrary directions. A *single* magnetic needle may be rendered astatic by placing a magnet near it. By repeated trials a certain position and distance can be found at which the action of the magnet on the needle just neutralises that of the earth's magnetism, and the needle is free to obey any third force." Practically, however, in electrical manipulation, the attainment of perfect astaticism is not desirable, because the needles would not take up a position of rest in a sufficiently short time for experimental purposes, and is practically improbable, because of the continuous and unequal variation in magnetic strength of the needles.

With the knowledge we have acquired of electrical laws let us now study Fig. 3, which represents in section the "Reflecting Galvanometer" of Sir William Thomson. The uses and importance of this galvanometer are many and much, but its accuracy is in some cases far less than is ordinarily supposed, as we shall presently indicate. N S (Fig. 3) is a light magnet of steel watch-spring, bearing a small circular mirror, both mirror and magnet weighing less than 1 grain. S N is a similar magnet, with reversed poles. The arrows indicate the direction of the current in the two coils of wire, and it should be noted that the magnetic effect of the current upon the system of needles is increased by reversing its direction in each coil. N V S is a semicircular bar-magnet, by raising or lowering which on the vertical rod the entire system may be rendered more or less astatic. The tendency of the poles of N V S is to repel the poles of N S. By varying the height of N V S almost any degree of delicacy may be attained. In what manner the little mirror is employed as a means of indicating the strength of current passing in the coils, must receive separate consideration.

Fig. 3.



The Royal Polytechnic.—Ever ready to afford to the public valuable information, the directors of this Institution have supplied a lecture, by Mr. J. L. King, entitled "Domestic Electricity, in its Application to Home Purposes," in which is elucidated, with the lecturer's usual facile manner, the uses of electricity to the householder. Science is so fast coming home to us that the idea of domestic telegraphy is by no means an alarming one. Electricity, it has been said, is the most tractable of the forces with which man deals, and it is time that the public should take a more general interest in the valuable agent. The apparatus with which the lecture is illustrated has been supplied by Mr. R. Offord, of Tichfield Street, and consists of a very complete collection of the electrical means for calling servants, giving the alarm in the case of fire, or burglars, &c. The application of electricity to the playing of an organ at a distant position is also illustrated by Mr. Gibbons. Altogether the lecture exhibits a very laudable tendency to place the common uses of electrical science clearly before the public, who will find it not the least interesting portion of the entertainment afforded by the Institution.

Presentation to Colonel Croll.—On the 23rd of August a large number of friends assembled at Granard Lodge, Roehampton, for the purpose of presenting to Mrs. Croll a portrait of her husband, Col. Croll, with an address in recognition of his services in chemistry, gas, and telegraphy. When director of the United Kingdom Telegraph Company, Col. Croll was the first to attempt the reduction of the charges for transmitting a telegraph message to a uniform tariff, and the attempt, though unsuccessful, was the forerunner of the present Government tariff. In one of the reports Mr. Scudamore states "that it would have been utterly impossible to have got over the powerful and determined opposition he met with in negotiating between the Government and the Telegraph Companies, prior to the transfer, but for the important services rendered by Colonel Croll."

THE TELEGRAPH IN THE DESERT.*

By K. JOYCE PERCEVAL.

I AM not going to write about any political or financial affairs, but simply confine myself to the part I took, as well as what I saw, during the erection of the telegraph to India through Mesopotamia, in Turkish Arabia, in 1863-4-5.

After the failure of the Red Sea cable between Suez and Aden became an established fact, the British Government obtained the sanction of the Sultan of Turkey to erect a land line from Bagdad to Bussarah, and a loop line from the former city to Kermanshah, where it joined the main line between Teheran and the port of Bushire in the Persian Gulf. The line to Bussorah, which runs between the Rivers Tigris and Euphrates, *via* Babylon and Hillah, is in the Turkish territory; but there are only 112 miles of the Kermanshah loop under the jurisdiction of the Turkish authorities, which extends 3 miles beyond the ancient town of Khanakean, and within 14 miles of the historic village of Kasr-Sherin, the first Persian place of permanent habitation on the Bagdad route to Teheran and Kermanshah. England paid for the cable and the materials for the land lines, and laid and erected both at her own expense.

It was to aid in the erection of the land lines that my services were engaged by the Under-Secretary of State for India.

The cable being finished, and the materials for the land lines shipped to the ports of destination, Bussarah and Bushire, I received orders from the Government (after having undergone a course of practical instruction at the telegraphic factories of Messrs. Siemens and Henley) to proceed to Bagdad, *via* Alexandria, Beyrout, Damascus, Palmyra, the Syrian Desert, and Kubisa.

Before my arrival most of the materials for the erection of the land lines were landed at Bagdad, and some portion was distributed along the intended direction which the lines were supposed to take. Every telegraph line is either suspended above ground by means of insulators fastened to wooden or iron posts, or laid underground, when the wire is protected by a covering of gutta-percha, and generally passed through iron or wooden tubes, such as can be seen daily in the streets of London. The lines I am now going to describe were all above ground, and the posts used were of cast- and wrought-iron, and manufactured by Siemens Brothers, of Great George Street, Westminster. Each post consists of a buckled foot-plate of wrought-iron, which is fastened to a cast-iron tube which forms the lower portion of the post. The top part is a wrought-iron welded tube combining great strength with lightness, and is fastened in the socket or lower portion of the post during erection by means of cement and small iron wedges, or by the conical end of the upper tube fitting tightly into the socket. A lightning discharger, commonly called a conductor, an iron rod 18 inches high and ½ an inch in diameter, is fastened into the top of the upper tube for the purpose of discharging atmospheric electricity. The insulators which I used, manufactured also by Siemens Brothers, were of porcelain, strengthened and protected by iron. I consider these to be the best materials of the many that have been patented or recommended. The insulators, which are divided into two classes, although used on the same line, are styled "intermediate" and "straining" insulators. Cost as follows:—Intermediate post insulators, according to size and quality, complete, from 1s. 3d. to 2s. each; straining or stretching insulators, complete as above, from 3s. 3d. to 4s. 6d. each. The iron parts of the insulators are painted with black varnish or galvanised. The number of insulators and posts required per mile varies according to the nature of the ground selected for the line. I used on an average, when on level ground, eighteen intermediate and three straining-posts to every mile; but on other occasions, where the ground was rocky or hilly, I used twenty-four and twenty-six posts, which gave a span of 73 yards 1 foot between the posts, whereas those erected on the level had a span of 83 yards 2 feet 5⅛ inches; but often in crossing from one cliff to another the spans were 150 and 200 yards. On these occasions I used Siemens Brothers' steel wire and elevated my posts, which can easily be done by putting several wrought-iron tops of intermediate posts on the top of the straining-posts, which I buried 5 or 6 feet in the ground. When the ground is level the strain on the intermediate insulators is nominal, unless there is too much dip or slack allowed between each post, which should never exceed in warm countries more than 18 inches to every 84 yards. I may add that curves never work so well as straight lines of telegraph, with more wear and tear of material, and larger original cost for erection.

The insulators are porcelain inverted cups, firmly cemented in a metallic covering, bell-shaped, cast-iron. A wrought-iron stalk is also cemented inside the porcelain cup, which has a hook on the end to support and retain the wire, which allows it to slide in the supporting hook when the temperature either expands or contracts the wire. The cast-iron bell protects the porcelain cup from injuries, and also from wet, which is essential in regard to insulation. The insulators are not liable—as glass, or some kinds of ebonite—to decrease in insulation after being exposed for some time to the weather; glass, owing to a chemical change of its surface, and ebonite, owing to numberless fine fissures which appear frequently on its surface, and absorb the humidity of the atmosphere.

Wooden posts, even in dry countries, seldom last more than five or six years before they must be replaced by new ones, without speaking of the expense incurred in putting them upright after every winter. I must say that the durability of wooden posts may be increased to some extent by the injection of sulphate of copper into the fibre of the wood; but that must be done just after the wood is cut down, or the expense incurred by the process is like throwing so much money away.

The iron posts patented by Siemens Brothers, and sent to me for erection, had been constructed with a view to obtain the greatest possible strength and durability with the least possible weight, and give each of the principal pieces composing the poles convenient shape for easy transport. The cost of each post and insulator complete is indeed very moderate if we only take into consideration that it will last, with proper care, between seventy and eighty years. The wrought-iron buckle-plate, already mentioned, gives to the pole stability and resistance against movement, and being round and gradually tapering upwards it presents but a very small surface to the wind and weather, whereas the clumsy, heavy, wooden post has no basis under ground to maintain it in its proper position; and even if it is plugged with heavy stones all round, the surface it presents to the wintry winds and rains will displace it, unless protected by a strong and costly ring of stays. There is another advantage to be gained by the iron post and foot-plate:—the post need not be sunk in the ground more than 2 feet 8 inches, whereas the wooden post must be embedded at least 4 feet beneath the surface of the ground, thereby costing for erection alone three times more than if the posts were iron.

About a month after my arrival at Bagdad, I received orders from the Resident to get myself in readiness in order to commence the erection of that part of the line between Bagdad and Hillah. I was ready a week before I could commence, owing to interested disputes among the local authorities. They had several rows and quarrels among themselves concerning the share each was to receive out of the amount they intended to plunder, through my agency, from the treasuries of Turkey and England.

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* Communicated by the Author, and abstracted from "Leisure Hour."

All difficulties being removed, nearly 100 workmen —of all colours, castes, and creeds—were handed over to me, with instructions to commence the erection of the intended line, with whom I marched out of Bagdad, and encamped on the banks of the Tigris, about 2 miles from the city.

With the exception of two or three of the Turkish serjeants attached to my camp, my followers did not know the names or uses of one single tool required for the work. Most of the men remained to receive the first week's pay; but when the muster-roll was called on Monday morning there were but twenty-five left out of the hundred which I took out with me.

During the second week I managed to secure the services of a number of Arabs. As I knew they were poor and faithful, I attached them to my staff, paid them well,* and in the course of three weeks they were able to handle nearly all the tools with great confidence and dexterity. I commenced to work and move on slowly, but I had not four men among eighty who could put the top post in its place straight.

Being able to speak to them in their own language, I instructed them in turns as to what they were to do, and how to use the different tools with which they were to accomplish that work allotted to them; and in the course of a fortnight (were it not for the dishonesty of my Turkish paymaster, who was daily in the habit of ill-using the men, with the view of their running away and leaving their pay in his hands) I might have had a well-instructed and contented staff, who would have been willing to remain with me until the completion of the line.

I was then removed to Bagdad and Bussarah.

Fig. 1

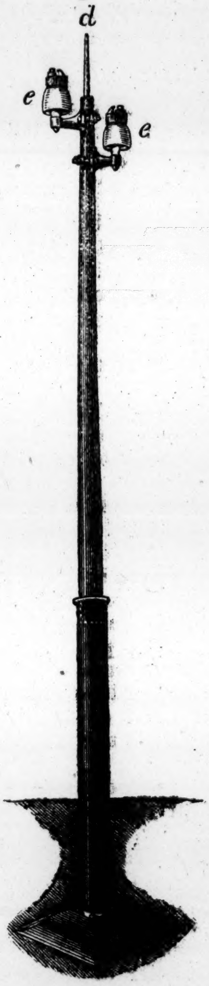


Fig. 7

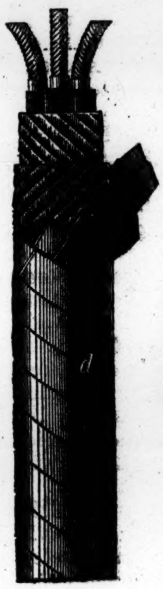


Fig. 5

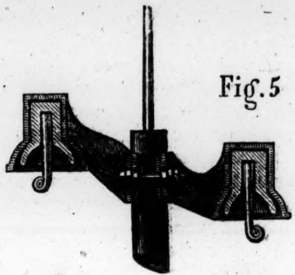
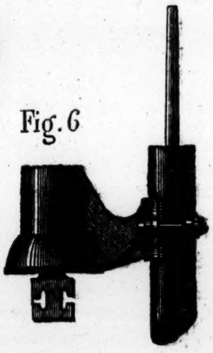


Fig. 6



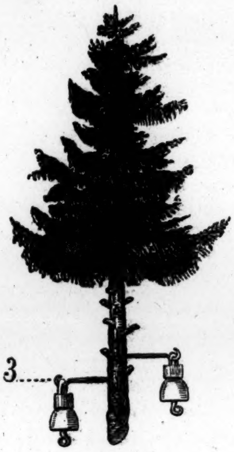


Fig. 3

Fig. 8

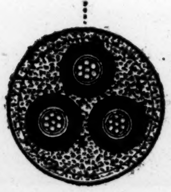
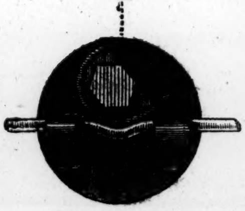


Fig. 2



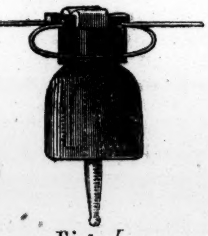


Fig. 4

Fig. 1.—An intermediate post, complete, with two insulators of porcelain, protected with iron caps, over which the wires pass.

Fig. 2.—An intermediate insulator, of porcelain, with an iron cap, fitted with a ratchet for retaining the wires in their places.

Fig. 3.—A tree substituted for a telegraph-post without cutting it down. This tree post could be made very useful on field days or in time of war, for three men on horseback, with light wire, small insulators, with no other tools than a large gimlet, a handsaw, and axe, could erect 6 miles a day, through a forest, if the way was clear. It is very handy in woody countries, especially where labour is dear and the transport of materials costly.

Fig. 4.—A straining insulator, of porcelain, with an iron cap and ratchet.

Fig. 5.—Section of the top of an intermediate post, with two insulators of porcelain, entirely covered with galvanised caps, and fitted with hooks to support the wire.

Fig. 6.—Section of the top of a straining-post, with insulator, complete, which is composed of porcelain, and covered or protected with an iron galvanised cap, and is mounted to the post by means of a screw.

Fig. 7.—A small piece of Mr. Siemens's late cables.

Fig. 8.—Section of Fig. 7, showing the conductors and the outer covering.

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* They received at the rate of a shilling per day, and it was the first time in their lives that these Arabs had ever received payment in money for their labour.

After I finished the Bagdad and Khanakean section I returned to Bagdad, and was again sent to complete the line from Duaniah to Omelegena, which I also accomplished without the aid of an European or Turkish soldier to protect me. My body-guard and companions were two old men, both said to be above 85 years of age; one of whom had a wooden leg and one eye; and yet, with a knowledge of the language and the character of the people, I was looked upon with greater respect and veneration than if I was escorted with a regiment of the Sultan's body-guard.

I append a few words more as to costs, which may be useful for estimates of such works, and also useful to those who may be hereafter called upon to give their opinion upon the value of private lines before purchase by the Government.

The expenses of construction depend—(1), on the nature of the ground in which the posts are put; (2), the expense of transporting and distributing the materials required; (3), the standing price of labour in the country or district through which the line runs.

A single line of 100 miles, with No. 6 wire of the best quality, and twenty-six wooden posts to the mile, with insulators, could be erected at the cost of £28 per mile, or £2800 for the whole line. The cost of erecting four telegraph stations, each station large enough for two writing instruments, would amount to another £400, and the eight ink-writing instruments cannot be got for less than £34 each, which will amount to £272. Adding together the different items, the single line of wooden posts in England will cost, for 100 miles, £3472; and a double line of the same length, with the same number of stations, instruments, and batteries, complete, would cost but £4272. The difference of cost between a single and a double line of 100 miles is thus only £800, or £8 per mile.

Electrical Science in Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvii., No. 4.

Galvano-Caustic and Electro-Thermic Appliances.—By M. Sédillot.—A note enumerating the applications of the galvanic current to thermo-cautery and chirurgical electrolysis. No cases are described, and the need for description of the principles has been forestalled in our electro-physiological column.

On a System of Pneumatic Telegraphy.—Note by MM. D. Tommasi and R. F. Michel.—The inventors employ ammoniacal gas instead of ordinary air as the medium of pressure.

No. 5.

Armatures Applied to Magnetic Bundles.—Note by M. Jamin.—If we superpose several magnetised plates, they react one upon the other, each destroying, in part, the magnetism of its neighbour, so that the carrying force of the bundle is less than the sum of the forces of every plate considered separately. The means of preventing for a time this reaction and the enfeeblement produced, consists in magnetising each plate separately, and then to apply a well-adjusted contact, and to superpose plates and contacts. The armatures afford a space where the magnetism accumulates which would be destroyed did they not exist.

Fourth Note on the Maxima Resistances of Magnetic Bobbins.—By. M. Th. Du Moncel.—In the different notes which I have addressed to the Academy on maxima resistances of magnetic helices, I have shown:—That a given helix produces its maximum effect when its own resistance is greater than that of the exterior circuit, in the ratio of 1 to $1 + \frac{c}{a}$; That for a bobbin of the same diameter, the helix which gives the best results is that of which the wire has a thickness and length such, that its resistance represents that of the exterior circuit; That the thickness of the magnetic helix should be equal to the diameter of the magnetic cores which it surrounds; That their length should be equal to this diameter multiplied by 11, and practically by 12. These deductions always suppose the exterior circuit to be perfectly insulated, the permanent state of the electrical propagation to be established, the reactions of the extra currents of the electro-magnet not to exist, and the iron of the electro-magnet to be under the conditions of saturation necessary for the applications of the laws of MM. Dub and Müller; when these conditions do not exist, the law does not hold good and calculation shows that the resistance of the helix should be considerably reduced, which the experiments of M. Hughes have proved in an unexceptionable manner, and these again are confirmed in a still clearer manner by the recent experience of M. Lenoir, where the electro-magnet employed underwent alternate magnetisations and demagnetisations with great rapidity, being adapted to an autographic telegraph. With elements so diverse it is impossible to lay down a formula which would give exactly the conditions of maximum of resistance of electro-magnetic bobbins. For the action of derivations, calculation shows that these conditions are the same as those already laid down, but by supposing that the resistance of the exterior circuir, R, on which they are based is represented by *the total resistance of the exterior circuit with its derivations*, and by admitting that this total resistance is considered as if the battery were substituted in the circuit for the electro-magnet. Now, when the total resistance of a circuit submitted to derivations is less than its individual resistance, the helix should have a resistance *less* than this latter. It remains for me to show the practical importance of the formulæ which I have laid down, and of the deductions which I have brought forth. The problem most frequently put forth, in the electrical applications, is this: *What dimensions should be given to an electro-magnet, and what thickness of wire should be employed in order to place it under the best conditions possible in a circuit of a given resistance*, R, *employing a battery of an electro-motive force*, E? Now, in order to determine the point of magnetic saturation of the iron of the electro-magnet, a matter I have not yet touched upon, it suffices to consider (according to the law of Müller) that, in order to develope in two electro-magnets the same aliquot part of their magnetic maximum, it is necessary that the intensities, I, of the current, multiplied by the number of turns, t, of the magnetic helix, should be proportional to the powers $\frac{3}{2}$ of their diameter. Consequently, if an electro-magnet is found under proper conditions of saturation for a certain electric force, it will be possible to determine, under given conditions, the diameter of another magnetic core, in order that it may be in analogous conditions of saturation. Now, this law, which may be translated by the equation—

$$\frac{I't'}{It} = \frac{\sqrt{C'^3}}{\sqrt{C^3}}$$

The quantity, c, being determined, the thickness of the wire is deduced from the equation—

$$H = \frac{2\,\pi\,c^3\,m}{g^2} \text{ or } R = \frac{2\,\pi\,c^3\,m}{g^2},$$

which gives, in relation to R, reduced to a function of g, and valued in metres of telegraphic wire of 4 millimetres in diameter—

$$g = \sqrt{f\sqrt{\frac{c^3}{R}} \cdot 0{\cdot}0001005312},$$

Hence, the real length of the wire of the helix may be determined, also the number of the spiral turns, because the quantity, *m*, is a constant, equal theoretically to 11 and practically to 12. In my researches on the best conditions of construction of electro-magnets, I give three tables, in which all the values relating to the electro-magnet that I have taken for a type are found indicated, as well as the forces produced, and which give in the same time the exact values of $f, f^2, g, g^2, \frac{g}{f}$, as well as the weights corresponding to a given length of the different wires most used, with or without a covering of silk.

On Electrical Condensation.—By M. Neyreneuf.—Air surrounding an electrified body suffers, like all other insulating bodies, the effect of penetration for the nearest molecules, and of orientation for those the most distant. The first would act, in the production of a spark, not by direct transmission, but like the isolating plate of a condenser, that is to say, by decomposition, by induction. This generalisation of the mode of action of an insulating medium cannot be proved by means of a condenser with a stratum of air, but we can justify it by remarking that a conducting ball, on an insulating stand, electrified, and then discharged by intimate contact with earth, preserves, during a very short time, an electrisation of the same kind, very sensible to the electroscope. By varying the conditions of the experiment, we see without difficulty that the residue observed is not due to the insulating substance forming the support. The fluid which has penetrated a certain thickness of air cannot be instantaneously neutralised, towards the exterior layers, which are at that time able to manifest a repulsion of the gold leaves. If we consider a Ramsden machine, in communication with an ordinary condenser, one derivation is established by the air and one by the condenser. The relative intensity of the two derivations varies with circumstances the most insignificant in appearance, and the charge of the insulating stratum is only constant (to produce a spark at a constant distance) under exceptional conditions of regularity in delivery from the machine. We can much reduce the influence of the derivation by the air, in using a Holtz machine, if we place it in communication with a strong battery. Under these conditions, the charge of the insulating plate soon produces, by an effect analogous to that of the secondary currents of batteries, the discharge of the machine and its charge in an inverse direction. We can assimilate the phenomenon of condensation to a true polarisation of the electrodes, and further this assimilation by means of the charge by cascade. Two condensers placed in cascade easily cause the interversions of charge which one alone was unable to produce. If we place a universal discharger between a Ramsden machine and some condensers in cascade, we prove that the number of sparks which we can cause to spring between the buttons of the discharger is limited, and that this number is as much smaller as the number of the condensers is greater, as if the tension of the secondary current increased with the number of elements. The derivation by the air then goes on increasing, and a Henley pendulum indicates, under these conditions, greater or less divergences. The charge of an insulating stratum varies with the nature of the electricity of the charge. This law, established by Matteuci in the case of feeble quantities, is easily verified for strong charges. The time of a charge, which permits, as we have seen, the penetration of the fluids into layers deeper and deeper, permits also, by lateral conductibility, the propagation of the fluids on the very edges of the insulating stratum. When these edges are sufficiently charged, their effect is added to that of the stratum itself in such a manner that some very irregular perturbations are produced in measures by the electroscope.

Les Mondes. Vol. xxxi., No. 16.

Curious Electrical Experiment.—By M. Broche, of Toulouse.—I hope a description of the following apparatus will be interesting. I do not know if it is new, but I have never seen it in any physical works. Two bands of paper are arranged as an armillary sphere, that is, the two circular bands of paper are placed at right angles. The bands at summit and base are pierced with two holes, in which passes a vertical wire armed at its two extremities with two small plates of cork. The little apparatus is fixed upon an electrical machine, and the following are the phenomena observed :—If the finger be placed to the left or to the right of the apparatus, it turns from the right to the left or from left to right, according to the position of the finger. If the change in the position of the finger be made quickly, the change of movement is also instantaneous. If the finger be raised or lowered while the apparatus is revolving, it mounts or descends the length of wire. The palm of the hand presented stops the movement. A metallic point produces the same result. During the rotation, a beautiful star appears at the end of the finger. A button of copper may replace the finger, but the movement is slower. M. Ruhmkorff has successfully repeated these experiments.

Journal de Physique. August, 1873.

Augmentation of the Induction Spark.—By M. C. M. Guillemin.—Everybody is acquainted with the experiment which consists in placing in communication the two coatings of a Leyden jar with the two ends of the secondary wire of an induction coil. The length of the spark is reduced considerably, but the brilliancy and noise are, on the contrary, increased. I wished to see the effect of large insulated metallic surfaces, placed in contact with the two ends of the secondary wire, the two surfaces being separated from each other, so as not to produce the effect of a condenser. For metallic surfaces I took frames having each about eleven square feet covered with silk, and this with tinfoil. The spark burst between two insulated points, which can be made to approach or recede from each other at will. So long as one or more plates of tin communicate with one of the poles only, the spark is in no way modified; but so soon as the other pole of the secondary wire is in contact with the plates of tin of the same surface as the first, the brilliancy of the spark increases and its length diminishes. The increase of the surface produces an increase in the brilliancy and the noise of the spark, and a new diminution in its length. If one of the metallic surfaces be greater than the other, the effect does not surpass that which two surfaces equal to the smallest produce. The effect of the plate becomes more sensible by the approximation of the points of the excitor, but if the distance of the points is reduced to a given minimum, the effect of the surface seems to disappear. When in place of the large metallic plates, metallic wires or ribbons of tinsel are employed, three-fourths to one inch in width, well insulated by means of glass supports or silk cords, we then obtain, by the use of equal surfaces, much more intense effects. Fifty-four yards of these metallic ribbons, placed in contact with each end of the secondary wire, making a total of 108 yards, greatly increase the brilliancy and the noise of the spark. The stronger the induction, the more marked the effect. In general the effects are the much more intense when the insulated metallic surfaces are larger and separated from each other.

Poggendorff's Annalen der Physik und Chemie, No. 5, 1873.

Electro-dynamic Phenomena dependent on Free Electricity at the Surface of Electrodes.—By Dr. Herwig.—

The electroscopic actions of the parts of a galvanic circuit have been often demonstrated; but in consideration of electro-dynamic actions, of attraction and repulsion, they are not taken into account, being thought so small. An explanation of the preponderance here is given in the fact that the free electricity is perceptible only at the circumference of the cross section, while the other (the current electricity) occupies the whole interior. If, however, we think of the free electricity as occupying not the mere mathematical surface, but a layer, though thin, then—by employing a very thin electrode—the proportionate action of the free electricity, in relation to the current, will become more important. Further, the force of the electricity may be increased by strengthening the electromotive force of the battery connected with it; and, on the other hand, the action of the current electricity can be weakened by diminishing the intensity of the current. To obtain the latter conditions, a strong battery may be used, and a powerful resistance inserted at will. From these stand-points Dr. Herwig has sought to estimate the influence of free surface electricity on electro-dynamic phenomena. He used a Weber electro-dynamometer, having on its bifilar cylinder 14,615, and on that of the multiplier 12,247, windings of fine copper wire. If the position of rest of the bifilar cylinder was at right angles to the other placed in the magnetic meridian, and a deflection occurred in the bifilar when a current passed through both coils, this deflection would be less in the case in which both coils were connected with the same pole (and so had free electricity of the same sign on their surfaces), and greater when the coils were connected with opposite poles, and a powerful resistance was inserted between them. If, again, the position of rest of the bifilar was inclined to that of the multiplier, and the bifilar were moved, by a current, towards the perpendicular position, the influence of the free electricity would here be the opposite. A series of such experiments are detailed, and the influence of free electricity seems to be put beyond doubt.

Remarks on the Pole-Points of a Magnet.—By E. Riecke.—In two cases the question of pole-points is of practical importance,—in determining magnetism from the deflection of a magnetic needle, and in determining strength of current with the tangent compass. The author starts with the assumption that the magnet to be considered has three planes of symmetry at right angles to each other, and the ideal distribution of magnetism at the surface of the magnet is symmetrical to these; also, that the current elements for which the pole-points are to be determined are considerably distant from the magnet (in proportion to its length). Formulæ are obtained, which mean the following:—About the middle point of a magnet describe, in a plane of symmetry passing through its axis, a circle with radius, R, such that the fifth power of the length of the magnet may be neglected in comparison with the fifth power of R. Then, with regard to all points lying beyond this circle in a radius passing through the middle of the magnet, we may replace the magnet by one and the same pair of magnetic poles; but the position of the pole-points changes with the direction of the radii. Only when the magnet has the form of a rotating body, having its axis coincident with the magnetic axis, is the position of the pole-points independent of the direction of the radii, and so the pair of poles is the same for all points lying outside the circle. M. Riecke compares these principles with results of experimental determination of the poles of a magnet of elliptical form, and those of the needle of a tangent compass. The position of poles in the latter depends in general on the angle of deflection; but if the needle has the form of a rotating body, the poles are the same for all angles of deflection.

On the Chemical Action of the Galvanic Current, and on the Distribution of Free Electricity on the Surface of an Electrode.—By M. E. Edlund.—Reserved for translation in full.

On M. von Bezold's Explanation of the Electric Disjunction Currents.—By E. Edlund.—According to von Bezold, Wiedemann, and Wüllner, the great difference of tension between the electrodes of the voltaic arc is the cause of these currents. M. Edlund holds, on the contrary, that they are caused by an electromotive force proper to the arc. The difference of tension must become much greater, he points out, when the electrodes are brought near each other and the arc is extinguished; but if, in such a case, the electrodes are connected with a galvanometer, there is no trace of a current, notwithstanding the great difference of tension. When, instead of the arc, an equal resistance is inserted, and the experiment repeated, there is here also no current. M. Edlund further dissents from Wiedemann's view, that the work done by a current in pulverising the electrodes is compensated through the resistance presented by the arc to propagation of the current. It was the impossibility of such compensation that led him (M. Edlund) to the discovery of the disjunction currents.

On the Spectra of Gases in Geissler Tubes.—By A. Wüllner.—In view of experiments by M. Schuster, who came to the conclusion that pure nitrogen gives only a line spectrum, M. Wüllner investigates whether the sparkless discharge and the band spectrum therewith may be obtained in the pure gas. He did obtain them at pressures from 5 m.m. to 185 m.m., at which latter the spark and line-spectrum first appeared. The phenomena were quite similar to those obtained with dry air. He further experimented as to whether the presence of sodium vapour in a mass of nitrogen gas hindered the sparkless discharge from appearing. It did not. Only the colour of the discharge was somewhat affected, while the flutings of the carbon spectrum were observed on the band-spectrum of nitrogen.

Estratto del Nuovo Cimento, Ser. 2, Vol. ix.

Is the Electric Current an Ether-Motion?—By M. Antonio Roiti.—As a test of the theory that the galvanic current is a motion of the luminiferous ether, M. Roiti describes an interesting experiment. If the theory is correct, the velocity of propagation of light in a body through which a galvanic current passes must vary with the direction of the current. The motion of the ether, in form of galvanic current in the body, will be added to that of the light waves, or subtracted from it, according to the direction; and such a difference may be observed in the interference-fringes of a ray of light. Solar rays, united in a focal line of a cylindrical lens, and made parallel by a spherical lens, were sent through a glass case having two divisions; passing through two slits parallel to the focal line of the cylindrical lens, and about the thickness of the partition apart. In exit the two rays interfered, and interference-fringes were observed. The case contained a solution of sulphate of zinc and four amalgamated zinc plates, which served as electrodes. They rested against the front and back walls of the divisions of the case, but were somewhat narrower than these, that passage might be afforded to the light rays which went close by the partition. The electrodes were so connected with the battery that the current had opposite directions in the two divisions. The currents were gradually increased in strength, till at last twenty Bunsen elements were used. "The fringes were displaced, but the displacement was slow, and *independent* of the direction of the current. It came always from that division which, containing a greater quantity of liquid, offered less resistance. In short it was, no doubt, an effect of heat developed by the electric current. And when the resistances in both columns of liquid were made equal, I found it impossible to perceive any difference in the fringes, whether the circuit was closed or broken, or whether the plates were neared to each other or withdrawn. I must remark, however, that the fringes were very small, and that my apparatus did not permit of enlarging them; further, that the floor shook, from noises outside. But in no case was there displacement the breadth of a fringe. It may be inferred, that if the galvanic current is a flow of ether, the velocity of the ether must be very small; more exactly, if we take the velocity of light as 298,000 kilometres per second, the wave-length 0·0006 m.m., and the length of the entire column of liquid 90 c.m. (the case was 45 c.m. long), the velocity in question must be less than 200 metres in the second,—a result which makes the hypothesis very improbable."

City and Commercial Notes.

The half-yearly meeting of the Mediterranean Extension Telegraph Company (Limited) was held on the 21st ult. at the London Tavern, Mr. H. Moor in the chair. The report stated that the traffic compared favourably with the corresponding half of 1872, the claim under the Government guarantee being less by some £300 than that for the above-mentioned period. The negotiations for a joint working with the Eastern Company through this company's Corfu-Otranto cable had not resulted in an agreement. The cables and land lines had been maintained in good order at a trifling cost. The payment by the Greek Government of moneys due from it to this company had been and still were delayed beyond the stipulated periods for payment thereof. The directors had pointed out to the Greek Director of Telegraphs that the regular distribution of the dividends must therefore be postponed, but at present the directors' representations had not been attended with success. The directors recommended payment of the usual half-yearly dividend on the 8 per cent preference stock of the company, less income-tax, payable on and after the 1st of September, and of a dividend at the rate of 3 per cent per annum on the ordinary share capital so soon as the moneys had been received from the Greek Government, leaving £491 to be carried to the reserve fund. The chairman said, with regard to postponing the payment of the ordinary dividend, a Liverpool shareholder had suggested that it should be taken from the reserve fund; but the directors would prefer borrowing the amount from the company's banker, and paying it back when they received the money. Sir J. Carmichael seconded the resolution for the adoption of the report. In reply to a question it was stated that £1,550 was due from the Greek Government up to the 30th of June last. The report was unanimously adopted; a dividend at the rate of 8 per cent. per annum was declared on the preference stock, payable on the 1st of September next, less income-tax, and at the rate of 3 per cent per annum, free of income-tax, on the ordinary share capital. On the motion of Mr. Robinson it was agreed to borrow the money from the company's banker to pay the dividend on the ordinary shares. The retiring directors were re-elected, and the proceedings terminated.

The first ordinary general meeting of the Central American Telegraph Company (Limited) and the Western and Brazilian Telegraph Company (Limited) were also held on the 21st ult., at the City Terminus Hotel; the chair was occupied by Mr. J. Heugh. The first meeting was commenced by the solicitor reading an agreement by which it was proposed that the two companies should enter into a joint purse arrangement, which he trusted the shareholders would approve. A resolution was then proposed recommending that the Central American Company's capital be increased by the addition of £100,000, divided into 5000 shares of £20 each, which would necessitate the alteration of certain articles of the memorandum of association. The resolution was passed, as were also two others, one modifying the 117th article by the omission of the words "the coupons shall not be expressed to be payable at any particular period;" and another altering the terms of declaration and payment of dividend whenever the profits of the company would permit. This terminated the business. The report of the Western and Brazilian Company was then read, and the chairman alluded to the satisfactory progress of the works of the company. The negotiations of Major A. Wood, their representative, had been very successful, and he had obtained the goodwill and assistance of the Brazilian Government and the naval authorities, who had placed at his service several ships for the purpose of sounding the rocky coast. His services could not be spoken of too highly. The adoption of the report was then carried, and a vote of thanks to the chairman closed the proceedings.

A dividend at the rate of 17 per cent per annum was declared, on the 19th ult., at the meeting of the Submarine Telegraph Company. Alluding to a remark made at a recent meeting of the Eastern Telegraph Company, to the effect that this Company seemed to fold its hands, the chairman (Sir James Carmichael, Bart.) said that inasmuch as the shares of the Submarine Telegraph Company are at 150 prem., and paying a dividend of 17 per cent, the shareholders can well afford to "fold their hands," and not show any great anxiety to join the Globe Company. At the same time he did not admit that the directors of the Submarine Telegraph Company are folding their hands, but said they are taking advantage of every opportunity to promote the welfare of the Company.

At a meeting of the board of directors of the Anglo-American Telegraph Company, Limited, held on the 22nd ult., it was resolved to pay an interim dividend of £2 per cent. free of income-tax, on the capital of the Company, viz., 7,000,000, for the four months ending the 31st instant. The register of transfers will be closed from the 10th to the 14th of September, both inclusive, and the warrants for the dividend will be payable on and after the 1st of October next.

An extraordinary meeting was held, on the 21st ult., of the Cape of Good Hope Telegraph Company, Limited, when the resolutions passed on the 5th inst., in favour of winding up the undertaking voluntarily, were confirmed.

The first or statutory meeting of the Globe Telegraph and Trust Company, Limited, was held on the 27th ult. From the report presented it appears that, of the 300,000 shares of £10 each offered to the public, the directors have allotted 224,532 shares, of which 112,266 were for preference shares, and the remainder —112,266—for ordinary shares. Of this number, 216,652 were issued in exchange for stock or shares of other companies. A reference to the fact that Mr. William Ford has been elected to a seat at the board was received with cheers. The chairman (Sir Daniel Gooch), in reply to a question, said he possesses no late information from the *Great Eastern*. On the 14th inst. she was at Heart's Content, and then had picked up a portion of the 1865 cable in 500 fathoms of water. The appearance and condition of the cable are stated to be much better than had been anticipated. Sir Daniel Gooch expressed an opinion that the *Great Eastern* has been detained by fogs, and it would be impossible for her to continue her search in foggy weather. The report was unanimously adopted.

The following communication was forwarded by the Telegraph Construction and Maintenance Company, on the 28th ult., to the Stock Exchange:—"By letter of the 20th August, from Captain Halpin, s.s. *Great Eastern*, lat. 51.50 N., long. 35.46 W., he reports having lifted the 1865 cable once, and found the fault still east of him. The cable shows a strength which leads Captain Halpin to hope the repairs will be effected if he has fine weather. Up to date he had had alternate fogs and gales."

THE INDO-EUROPEAN TELEGRAPH COMPANY.—Time occupied by messages in transmission from England to India, *via* Teheran:—For the week ending 22nd August, 1873: longest time taken by any message, 4 hours 10 min.; shortest time taken by any message, 17 min.; average time of all messages, 1 hour 32 min.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	Aug. 29.
Stock	Anglo-American (Limited)	100	90—91
10	Brazilian Submarine..	7	2—1½ dis.
10	Cuba	All	9¼—9¾
10	Direct Spanish	9	½dis.—½pm
20	Direct United States Cable	8	7—5 dis.
10	Eastern (Limited)	All	9—9¼
10	Ditto New	All	8⅞—9⅛
10	Eastern Extn. Australia and China	All	8¾—9
10	Great Northern	All	9½—10
25	Indo-European	All	15—17
10	Mediterranean Extension (Limited)	All	5¼—5¾
10	Do., 8 per cent Pref...	All	10½—11½
8	Reuters	All	10½—11½
Stock	Submarine	100	237—247
1	Do., Scrip	All	2¼—2½
10	West India and Panama	All	6¾—7
10	Do., 10 per cent Pref.	7½	⅞—1⅛ pm.
20	Western and Brazilian (Limited) ..	18	7—5 dis.
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	93—95
10	Hooper's Telegraph Works	All	13¼—13¾
50	India-Rubber and Gutta Percha ..	All	30—31
Cert.	Submarine Cables Trust	100	113—115
12	Telegraph Construction	All	33½—34
100	Ditto Ditto 7 per cent Bonds	100	102—105

THE ELECTRIC LIGHT.—It will be remembered that, in April last, an analogy was pointed out between sunlight and the electric light, and that certain conditions were therein indicated as being most favourable to that particular development of light which would best bring out the separation of the power producing the light from the place of its manifestation. Those conditions were the employment of magneto-electricity, and the use of a closed incandescent conductor in an atmosphere which would not oxidise or otherwise affect the durability of the light-producing material. From the quotation from the Russian paper *Golos* which follows, it will be seen that the results anticipated are even now in the course of realisation, and all that practical men can do is, to wish the plan the success it seems to deserve, and to wait the result of the further exhibitions of its power in London and other places more accessible to the Western nations than St. Petersburg:—"On Tuesday, the 8-20 of May, a most interesting trial was made, for the first time in public, at the Admiralty House, St. Petersburg, under the auspices of Messrs. S. A. Kosloff and Co., the proprietors of the patent, of a new system of lighting by electricity, the invention of Mr. A. Ladiguin, of that town. Owing to the restricted space in the hall made use of on this occasion, the number of spectators was necessarily limited, but still they consisted of more than a hundred specialists from different countries, representatives of science, honourable visitors, and many reporters, who were all deeply interested, and unanimously decided that the trial was really successful. Up to the present time, as is well known, the electric light has been used only for lighthouses, as an electric sun illumination for signals, or on the stage, where a strong light may be required without regard to cost; but thus far it has been quite impossible to employ it for lighting streets or houses. By the old method the electric spark was passed between two points of charcoal, each attached to a copper wire connected with an electro-magnetic machine. The disadvantages attending this mode consisted in the facts, that for each light a separate machine was required, and that the light so obtained, although very powerful, was impossible to be regulated, besides being non-continuous, owing to the rapid consumption of the charcoal points from exposure to air. All these difficulties Mr. A. Ladiguin has tried, and apparently overcome most successfully. By his newly-invented method, only one piece of charcoal or other bad conductor is required, which, being attached to a wire connected with an electro-magnetic machine, is placed in a glass tube, from which the air is exhausted, and replaced by a gas which will not at a high temperature combine chemically with the charcoal. This tube is then hermetically sealed, and the machine being set in motion by means of a small steam-engine, the charcoal becomes gradually and equally heated, and emits a soft, steady, and continuous light, which, by a most simple contrivance, can be strengthened or weakened at the option of those employing it, its duration being dependent solely on the electric current, which of course will last as long as the machine is kept in motion. Taking into consideration the fact that one machine, worked by a small three-horse power engine, is capable of lighting many hundreds of lanterns, it is evident that an enormous advantage and profit could be gained by the illumination of streets, private houses, public buildings, and mines, with the new electric light. In the latter it must prove invaluable, as no explosion need ever be feared from it, and these lanterns will burn equally as well under water as in a room. Without mentioning the many advantages this mode of illumination has over gas, which by its unpleasant odour and evaporation is slowly poisoning thousands of human beings, and from which explosions are frequent, we can state that, by calculations made, this electric light can be produced at a fifth of the cost of coal-gas. We hope shortly to place before the public more complete particulars, as well as reports of further experiments which are proposed to take place in Vienna, Paris, and London."—*Golos*, No. 129, and *Journal of the Society of Arts*, August 22, 1873.

To Correspondents.

*** The publisher, having received numerous letters complaining of the irregular supply of the Journal by Newsagents, begs to state that it will be sent direct from the Office on the day of publication, post free, on receipt of Annual Subscription of 9s. by Post-Office Order.

PRIZES TO STUDENTS.

IT has been decided to offer, from time to time, to our Students, prizes for the best and most carefully considered paper on a given subject. By the kindness and courtesy of Mr. Robert Sabine, C.E., who has placed the funds at our disposal, we are enabled to commence the series with a

PRIZE OF £25,

to be awarded to the Author of the best paper on "The Evidence of the Theory of Correlation of Physical Forces as applied to Electricity and Magnetism," received by the Editor of this Journal on or before January 1st, 1874. Each paper submitted for competition must describe original experiments. Each paper to bear (on every leaf) some word or motto by which it may be recognised. The same word or motto to be inscribed on a sealed envelope containing real name and address of competitor. The papers not selected will be destroyed with the envelopes unopened. Papers to be addressed to the Editor, and endorsed "Students' Prize." The best papers will be selected and submitted to a Committee of well-known Electrical Authorities (whose names will be published), who will award the prize for the most carefully prepared paper, irrespective of the view taken by its Author, whether favourable or unfavourable to the new theory. The award to be final. The Prize Paper to be printed in the columns of this Journal.